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# Description

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## Overview

This document describes the various trunk cards that are used with the Meridian 1 switch. It describes the Meridian 1 architecture, the trunk cards themselves, and how the cards fit into the Meridian 1 architecture. It also shows how the cards are used at the customer site, and how they are installed and programmed. It also provides detailed technical specifications on each of the cards.

The following nine trunk cards are described in this document:

- NT8D14 Universal Trunk Card
- NT8D15 E&M Trunk Card
- QPC71 E&M/DX and Paging Trunk Card
- QPC74 Recorded Announcement Trunk Card
- QPC237 4-Wire E&M/DX Trunk Card
- QPC239 Recorded Telephone Dictation Trunk Card with DCK feature
- QPC250 Release Link Trunk Card
- QPC449 Loop Signaling Trunk Card
- QPC450 CO/FX/WATS Trunk Card

## Meridian 1 architecture

A Meridian 1 switch is a digital telephone system that provides both voice and data transmission. The internal hardware is divided into the following functional areas (see [Figure 1](#)).

### Common equipment

Common equipment circuit cards provide processor control, software execution, and memory functions to the system. Meridian 1 processor functions are executed by the system software in the CPU module (sometimes called a Core module). This module is normally located at the bottom of the Meridian 1 column. The CPU manages the telephone switching functions by responding to interrupt requests from the network and peripheral equipment. It also performs the following housekeeping functions:

- controls call origination, call termination, and feature operation for switched voice and data calls
- executes system administration and configuration functions
- coordinates system diagnostic activities
- controls system utility functions such as software loading, initialization, data dumping, traffic logging, and system auditing

### Network equipment

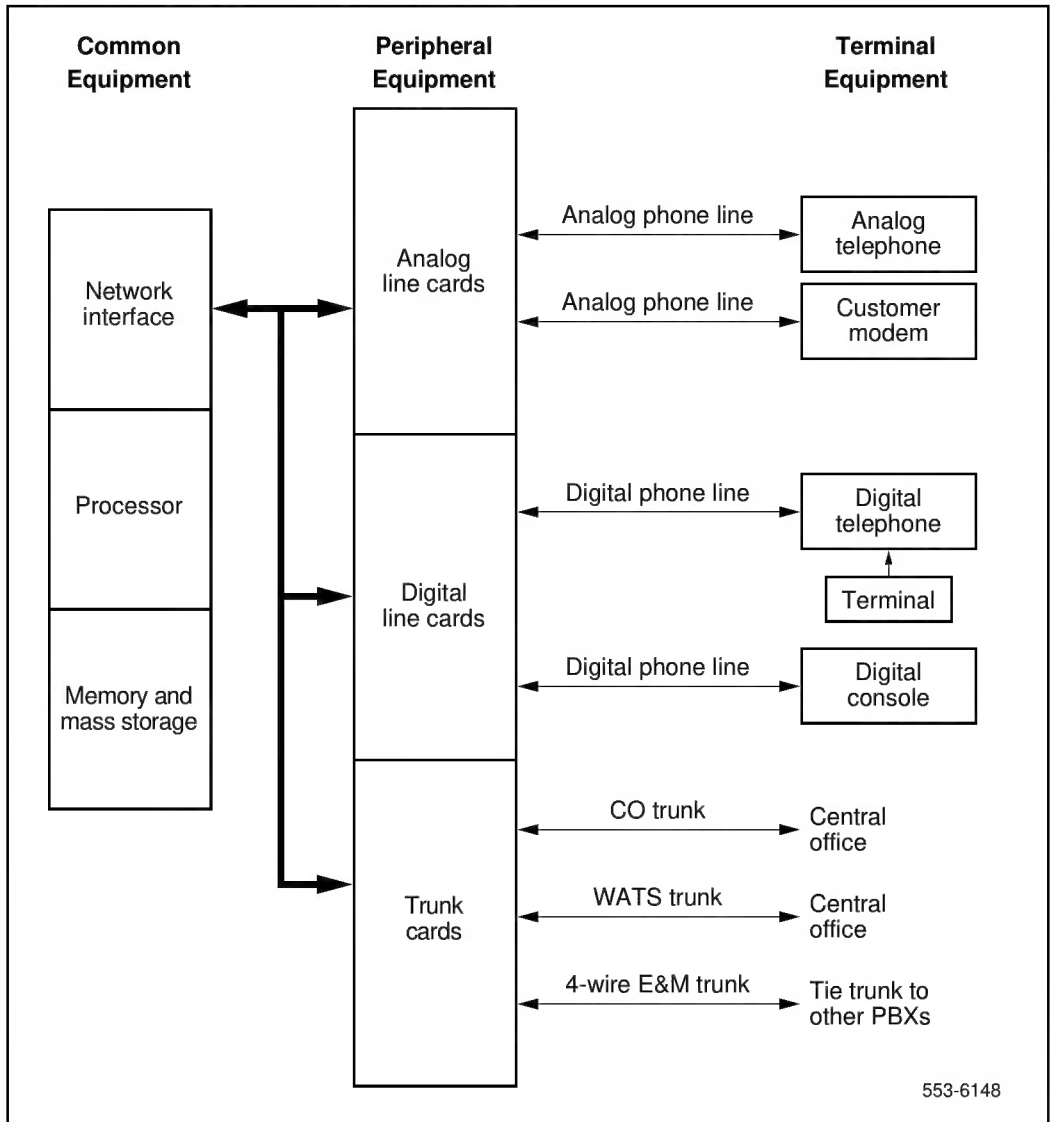
Network interface circuit cards perform data and control switching functions between the processor and peripheral equipment cards.

**Note:** As shown in [Figure 1](#), the network interface function is generally considered a subset of the common equipment functions.

Some of the functions that network equipment performs include:

- hardware initialization and self-test upon power-up
- establishing call connections between stations connected to remote IPE line cards and stations local to the Meridian 1
- establishing call connections to trunks for long distance trunk calls over public or private networks
- providing local and remote loopback testing and fault isolation functions

**Figure 1**  
**Trunk cards in the Meridian 1 architecture**



### **Peripheral equipment**

Peripheral equipment circuit cards provide the interface between the network and connected devices, including trunks and terminal equipment. Functions performed by peripheral equipment include:

- performing initialization and self-tests upon power-up
- managing timeslots to line and trunk cards to establish call connections
- providing Card-LAN management information by reporting card and port status
- controlling local station dialing and ringing functions
- providing local and remote loopback testing and fault isolation functions

Trunk cards are peripheral equipment circuit cards that are used to connect the Meridian 1 switch to line facilities and special services. These facilities include:

- Central office trunks
  - Central office trunks (CO)
  - Wide Area Telephone Service trunks (WATS)
  - Direct inward dial trunks (DID)
  - Foreign Exchange trunks (FX)
  - Central Automatic Message Accounting trunks (CAMA)
  - Common Control Switching Arrangement trunks (CCSA)
- PBX—PBX tie trunks
  - Tie trunks (TIE)
  - Release trunks (RLT)
- Special services
  - Recorded Announcement trunks (RAN)
  - Music trunks (MUS)
  - Paging trunks (PAG)
  - Dictation trunks (DIC)

### **Terminal equipment**

Terminal equipment includes telephones and attendant consoles. It may include equipment such as data terminals, printers, and modems.

Complete details on the architecture of the Meridian 1 switch are given in *Meridian 1 system overview* (553-3001-100).

## **Selecting a trunk card**

Each of the trunk cards was designed to fit a specific system need. [Table 1](#) will help you select the trunk card that will best meet your needs.

### **Intelligent peripheral equipment (IPE) trunk cards**

The following trunk cards are designed using the intelligent peripheral equipment (IPE) architecture, and are recommended for use in all new system designs.

#### **NT8D14 Universal Trunk Card**

The NT8D14 Universal Trunk Card is an intelligent four-channel trunk card that is designed to be used in a variety of applications. It supports the following five trunk types:

- Central office (CO), Foreign Exchange (FX), and Wide Area Telephone Service (WATS) trunks
- Direct inward dial (DID) trunks
- Tie trunks: two-way loop dial repeating (LDR) and two-way loop outgoing automatic incoming dial (OAID)
- Recorded Announcement (RAN) trunks
- Paging (PAG) trunks

The universal trunk card also supports Music, Automatic Wake Up, and Direct Inward System Access (DISA) features.

**Table 1**  
**Trunk card characteristics**

| Part Number                                                                                  | Description                                | Trunks | Trunk Types                                                                                                                                         | Architecture |
|----------------------------------------------------------------------------------------------|--------------------------------------------|--------|-----------------------------------------------------------------------------------------------------------------------------------------------------|--------------|
| NT8D14                                                                                       | Universal Trunk Card                       | 8      | CO/FX/WATS trunks*,<br>direct inward dial trunks,<br>tie trunks,<br>Loop Dial Repeating trunks<br>Recorded Announcement<br>trunks,<br>Paging trunks | IPE          |
| NT8D15                                                                                       | E&M Trunk Card                             | 4      | 2-wire E&M trunks,<br>4-wire E&M trunks,<br>4-wire DX trunks,<br>Paging trunks                                                                      | IPE          |
| QPC71                                                                                        | E&M/DX Signaling and<br>Paging Trunk Card  | 2      | 2-wire E&M trunks,<br>2-wire DX trunks,<br>4-wire DX trunks,<br>Paging trunks                                                                       | IPE          |
| QPC74                                                                                        | Recorded<br>Announcement Trunk<br>Card     | 4      | Recorded Announcement<br>trunks                                                                                                                     | PE           |
| QPC237                                                                                       | 4-wire E&M/DX Trunk<br>Card                | 2      | 4-wire E&M trunks,<br>4-wire DX trunks                                                                                                              | PE           |
| QPC239                                                                                       | Recorded Telephone<br>Dictation Trunk Card | 2      | Recorded Telephone<br>Dictation trunk                                                                                                               | PE           |
| QPC250                                                                                       | Release Link Trunk Card                    | 2      | Release Link trunks                                                                                                                                 | PE           |
| QPC449                                                                                       | Loop Signaling Trunk<br>Card               | 4      | Direct inward dial trunks,<br>direct outward dial trunks,<br>loop dial repeating trunks                                                             | PE           |
| QPC450                                                                                       | CO/FX/WATS Trunk Card                      | 4      | CO/FX/WATS trunks                                                                                                                                   | PE           |
| * Central office (CO), Foreign Exchange (FX), and Wide Area Telephone Service (WATS) trunks. |                                            |        |                                                                                                                                                     |              |

**NT8D15 E&M Trunk Card**

The NT8D15 E&M Trunk Card is an intelligent four-channel trunk card that is designed to be used when connecting to the following types of trunks:

- 2-wire E&M Type I signaling trunks
- 4-wire E&M trunks with:
  - Type I or Type II signaling
  - Duplex (DX) signaling
- paging (PAG) trunks

The trunk type and function can be configured on a per port basis. Dialing outpulsing is provided on the card. Make and break ratios are defined in software and downloaded by software commands.

**Peripheral equipment (PE) trunk cards**

The following trunk cards are designed using the older peripheral equipment (SL-1) architecture. They are available to upgrade an existing system, but should not be used in new system designs.

**QPC71 E&M/DX Trunk Card**

The QPC71 E&M/DX Trunk Card is a two-channel trunk card that is designed to be used when connecting to the following types of trunks:

- E&M signaling, 2-way dial repeating trunks
- 2-wire DX signaling, 2-way dial repeating trunks where signaling and transmission are via hybrid transformer
- 4-wire DX signaling, 2-way dial repeating trunks where signaling is via the A1 and B1 leads to a 24V4 repeater mounted externally to the Meridian 1, and transmission is via a hybrid transformer to the terminating set of the 24V4 that converts the trunk from 2-wire to 4-wire
- paging (PAG) trunks, dial access or attendant access via the press-to-talk key

The QPC71 can offer either 600 $\Omega$  or 900 $\Omega$  balanced terminating impedance (selected at the cross connect terminal). It also includes a 2-dB pad to control the gain between line-to-trunk and trunk-to-trunk connections on non-VNL connections, and gain control and echo protection on VNL through balance and terminal balance connections.

### **QPC74 Recorded Announcement Trunk Card**

The QPC74 Recorded Announcement Trunk Card is a four-channel trunk card that is designed to be connected to a variety of recorded announcement machines. Up to five different intercept conditions can be defined that will result in a connection to a recorded announcement machine. Some examples of these conditions are:

- access denied: “You are not allowed access to the number you have dialed. Please dial 0 for assistance.”
- call to a vacant number: “The number you have dialed is not in service. Please check your directory and call again.”

The QPC74 allows selectable termination of the tip and ring impedance using 300 $\Omega$  distributing resistors. This allows bridging of up to ten trunks to a single low-impedance (2 $\Omega$  or 4 $\Omega$ ) recorded announcement channel. It also supports both continuous and start/stop modes of operation.

### **QPC237 4-Wire E&M/DX Trunk Card**

The QPC237 is a two-channel, 4-wire E&M/DX trunk card that provides 4-wire voice transmission with E&M or DX signaling without the necessity of going through external 2- to 4-wire conversion. It allows connection to 4-wire trunks that use both Type I and Type II signaling.

### **QPC239 Recorded Telephone Dictation Trunk Card**

The QPC239 Recorded Telephone Dictation Trunk (RTDT) card is a two-channel card that directly interfaces with a variety of customer-provided recorded announcement equipment to allow the user to record an announcement. The RTDT card can be selected to allow either transmission or no transmission during dialing (switch setting). It also has a software switchable 4-dB pad that allows gain control between line-to-trunk and trunk-to-trunk connections.



**QPC250 Release Link Trunk Card**

The QPC250 Release Link Trunk (RLT) Card is a two-channel trunk card that is used at a remote site to allow access to the main site Centralized Attendant Service (CAS) attendant. An RLT circuit consists of a trunk circuit at a remote private branch exchange (site) to be served by a CAS attendant, and an interfacing trunk circuit at the main site where the CAS attendant is located.

**QPC449 Loop Signaling Trunk Card**

The QPC449 Loop Signaling Trunk Card is a four-channel trunk card that can interface with any of the following trunk types:

- direct inward dial (DID) and direct outward dial (DOD) trunks
- loop dial repeating (LDR) tie trunks
- two-way dial outgoing automatic incoming dial (OAID) tie trunks
- outgoing automatic number identification (OANI)

The QPC449 can offer either 600 $\Omega$  or 900 $\Omega$  balanced terminating impedance (selected at the cross connect terminal). It also includes a 4-dB pad to control the gain between line-to-trunk and trunk-to-trunk connections (on the receive or digital-to-analog side).

**QPC450 CO/FX/WATS Trunk Card**

The QPC450 CO/FX/WATS Trunk Card is a four-channel trunk card that connects to central office (CO), Foreign Exchange (FX) and Wide Area Telephone Service (WATS) trunks. The QPC450 can offer either 600 $\Omega$  or 900 $\Omega$  balanced terminating impedance (selected at the cross connect terminal).

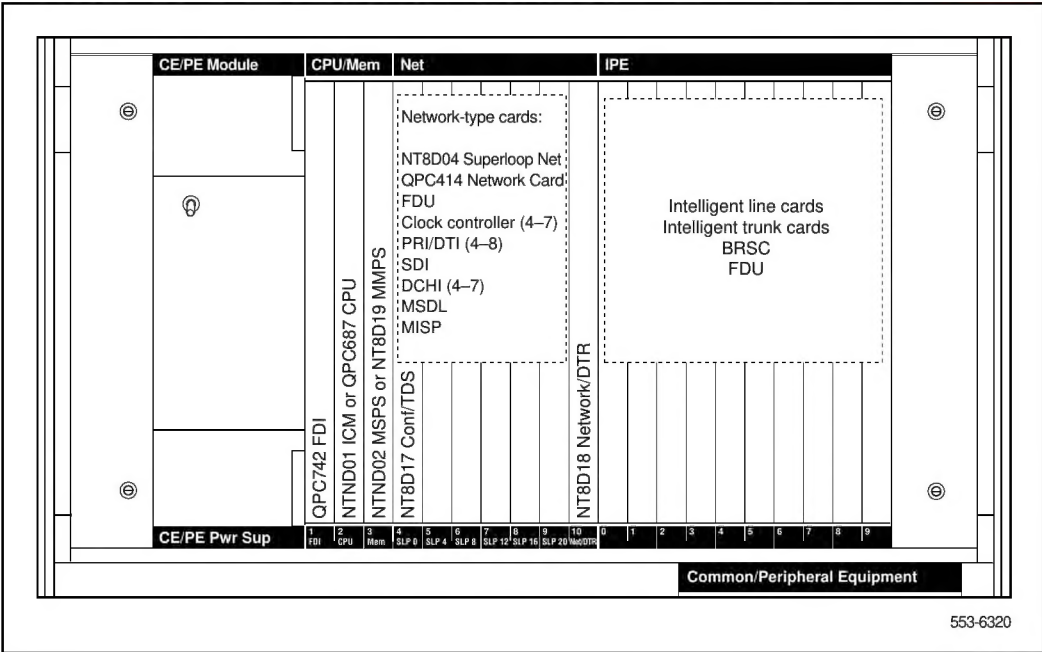
Installation

This section provides a high-level description of how to install and test trunk cards. For specific installation instructions, see *Circuit card installation and testing* (553-3001-211).

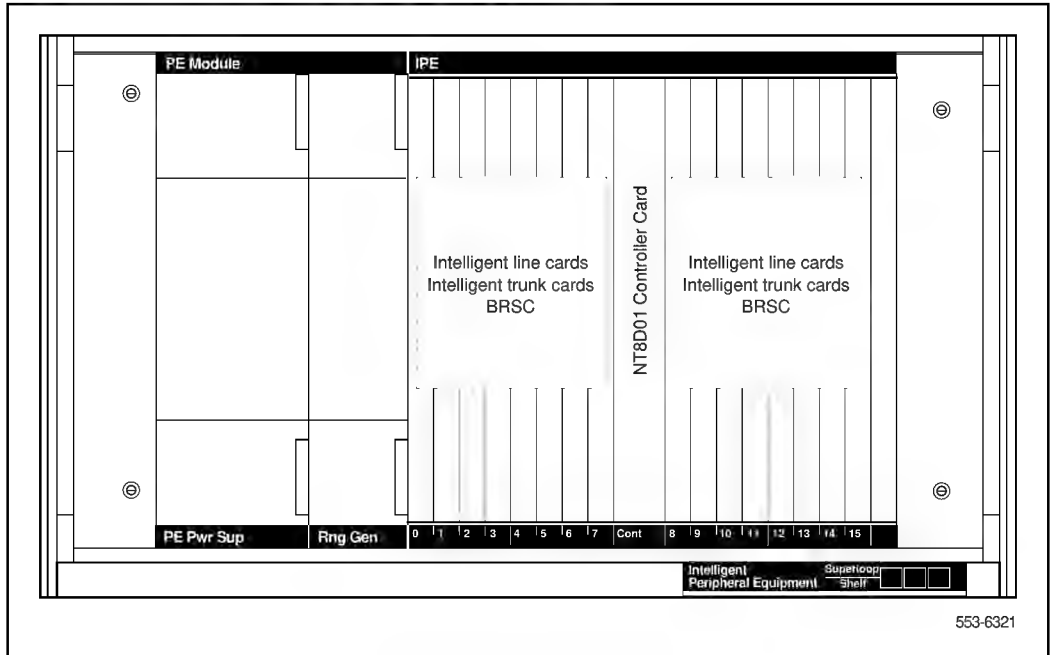
Intelligent peripheral equipment (IPE) trunk cards can be installed in any IPE slot of either the NT8D11 Common/Peripheral Equipment (CE/PE) Module or the NT8D37 Intelligent Peripheral Equipment (IPE) Module. [Figure 2](#) shows where an IPE trunk card can be installed in an NT8D11 CE/PE module, and [Figure 3](#) shows where an IPE trunk card can be installed in an NT8D37 IPE Module.

Peripheral equipment (PE) trunk cards can be installed in any PE slot of the NT8D13 Peripheral Equipment Module. This is shown in [Figure 4](#).

Figure 2  
IPE trunk cards installed in an NT8D11 CE/PE Module



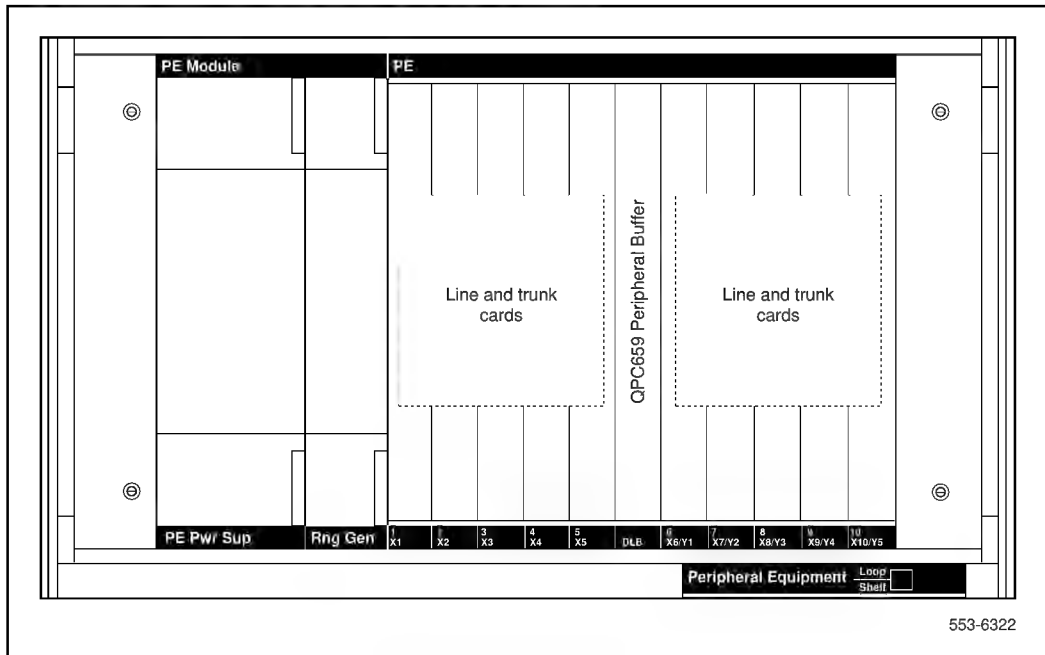
**Figure 3**  
**IPE trunk cards installed in an NT8D37 IPE Module**



When installing trunk cards, these general procedures should be used:

- 1 Configure the jumpers and switches on the trunk card (if any) to meet your system needs.
- 2 Install the trunk card into the slot that you have selected.
- 3 Install the cable that connects the backplane connector on the PE or IPE module to the module I/O panel.
- 4 Connect a 25-pair cable from the module I/O panel connector to the main distribution frame (MDF).

**Figure 4**  
**PE trunk cards installed in an NT8D13 PE Module**



- 5 Connect the trunk card output to the selected terminal equipment at the MDF.
- 6 Configure the individual trunk interface unit using the Trunk Administration program (LD 14) and the Trunk Route Administration program (LD 16).

Once these steps have been completed, the trunk card is ready for use.

## Operation

This section describes how trunk cards fit into the Meridian 1 architecture, the buses that carry signals to and from the trunk cards, and how they connect to terminal equipment. To fully understand the operation of these cards, you must understand the differences between peripheral equipment (PE) and intelligent peripheral equipment (IPE). See [Table 2](#).

### Host interface bus

The original (SL-1 architecture) switches that Northern Telecom produced used a bus standard for line and trunk cards called the peripheral equipment (PE) bus. Newer switches (Meridian 1 architecture) use an improved version of this bus: the intelligent peripheral equipment (IPE) bus. Meridian 1 based switches are designed to be able to interface with the older PE based cards. This allows existing SL-1 switches to be upgraded to the Meridian 1 architecture without the expense of throwing away the existing wiring, PE modules, and line and trunk cards.

Cards based on the IPE bus have a built-in microcontroller; cards based on the PE bus do not. The IPE microcontroller is used to perform local diagnostics (self-test), configure the card according to instructions issued by the Meridian 1 system processor, and report back to the Meridian 1 system processor information such as card identification (type, vintage, and serial number), firmware version, and programmed configuration status.

**Note:** IPE cards and modules should be used in all new designs. PE equipment should only be specified when upgrading an existing system.

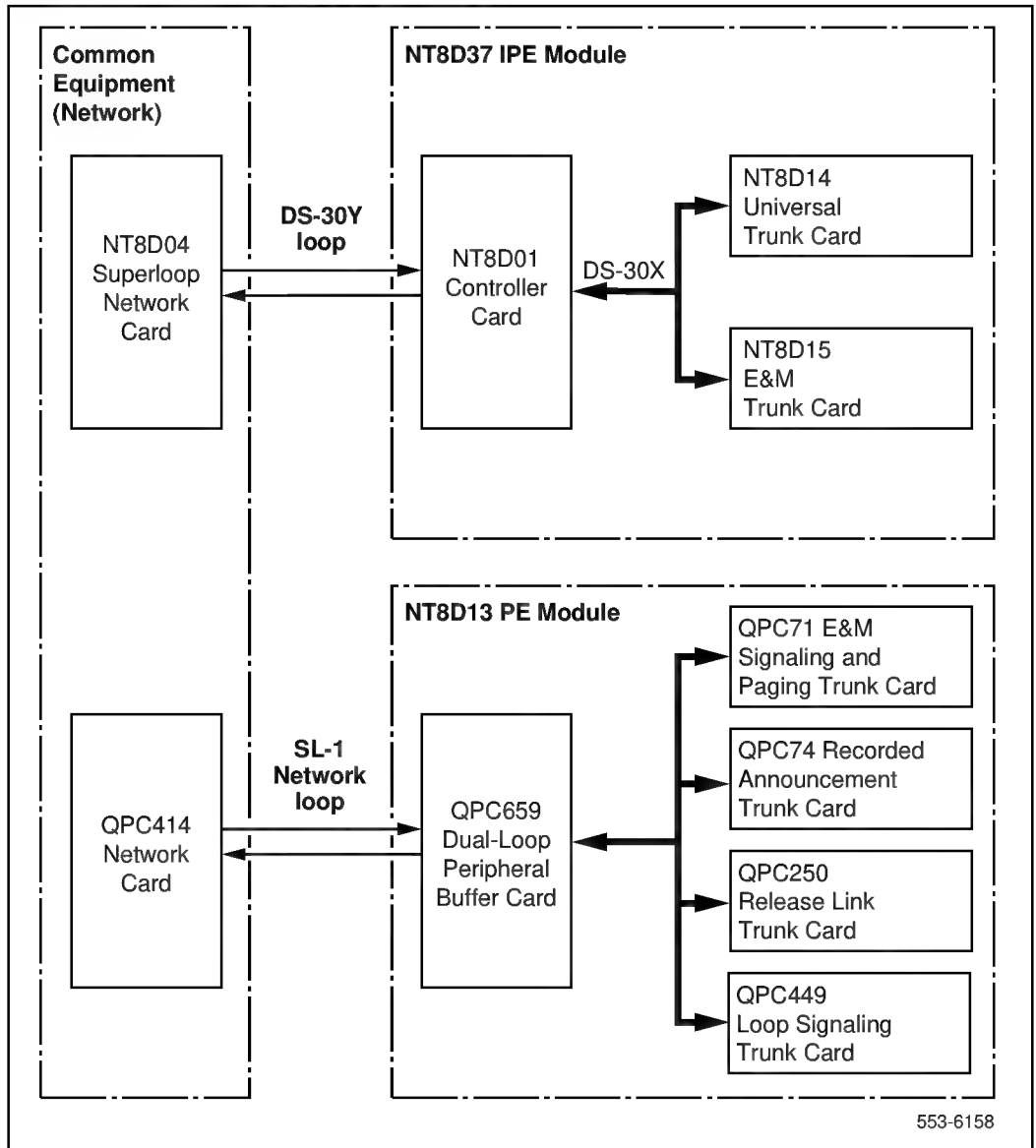
### Intelligent peripheral equipment

Intelligent peripheral equipment (IPE) trunk cards all have a similar architecture. [Figure 6](#) shows a typical IPE trunk card architecture. The various trunk cards differ only in the number and types of trunk interface units.

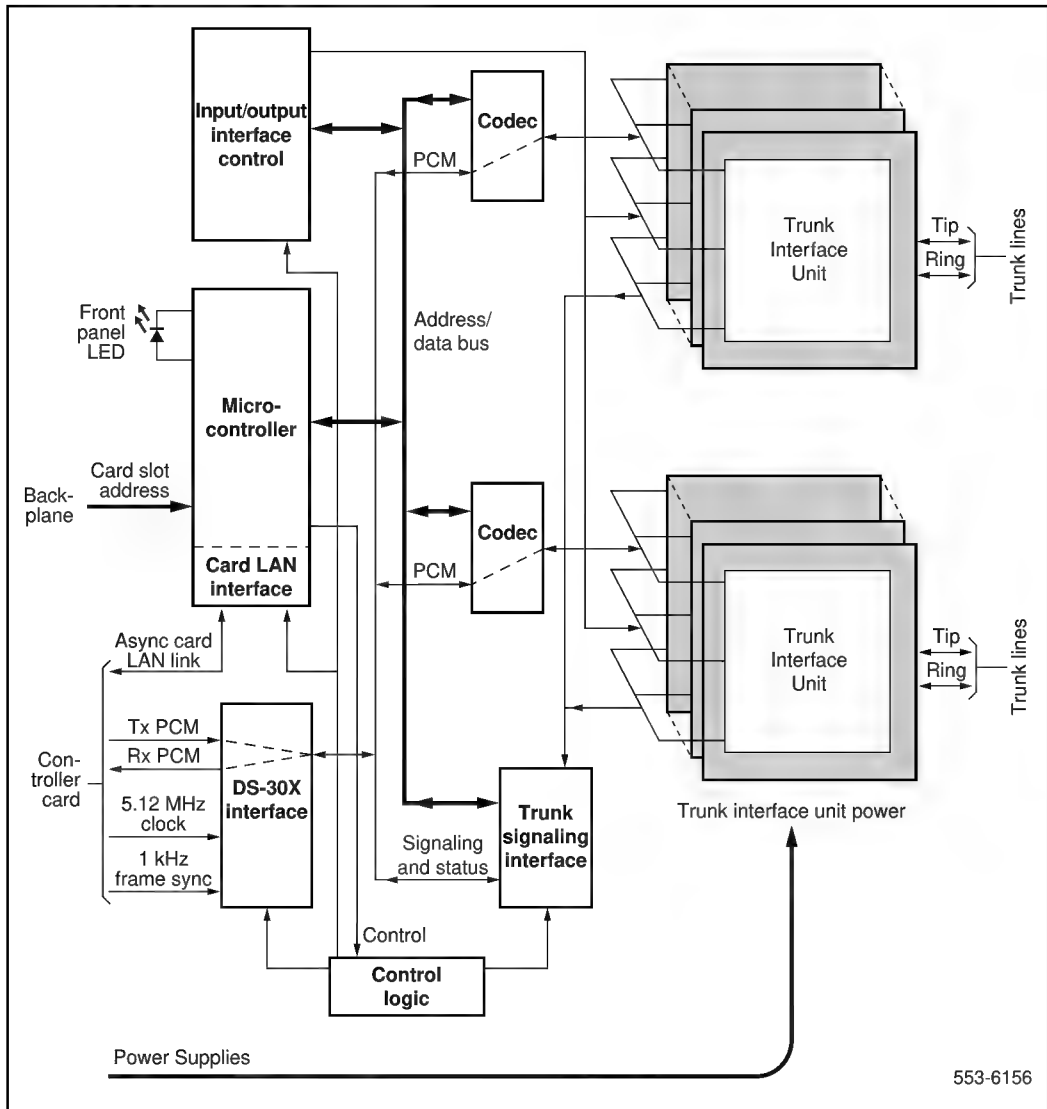
**Table 2**  
**Differences between PE and IPE modules**

| <b>Parameter</b>          | <b>Peripheral Equipment</b>                      | <b>Intelligent<br/>Peripheral Equipment</b>        |
|---------------------------|--------------------------------------------------|----------------------------------------------------|
| Card Dimensions           | 31.75 x 25.4 x 3.6 cm.<br>(12.5 x10.0 x 1.4 in.) | 31.75 x 25.4 x 2.2 cm.<br>(12.5 x10.0 x 0.875 in.) |
| Network Interface         | SL-1 Network Loops                               | DS-30X Loops                                       |
| Communications Interface  | via the SL-1 Network Loop                        | card LAN Link                                      |
| Microcontroller           | None                                             | 8031                                               |
| Peripheral Interface Card | QPC659 Dual-loop<br>Peripheral Buffer Card       | NT8D01 Controller Card                             |
| Network Interface Card    | QPC414 Network Card                              | NT8D04 Superloop Network<br>Card                   |
| Modules                   | NT8D13 PE Module                                 | NT8D37 IPE Module<br>NT8D11 CE/PE Module           |

**Figure 5**  
**Network connections to PE/IPE modules**



**Figure 6**  
**Typical IPE trunk card architecture**





The Meridian 1 switch communicates with IPE modules over two separate interfaces. Voice and signaling data are sent and received over DS-30X loops and maintenance data is sent over a separate asynchronous communications link called the card LAN link.

Signaling data is information directly related to the operation of the telephone line. Signaling commands include, but are not limited to:

- off hook/on hook
- ringing signal on/off
- message waiting lamp on/off

Maintenance data is data relating to the setup and operation of the IPE card, and is carried on the card LAN link. Maintenance data includes, but is not limited to:

- polling
- reporting of self-test status
- CPU initiated card reset
- reporting of card ID (card type and hardware vintage)
- reporting of firmware version
- downloading trunk interface unit configuration
- reporting of trunk interface unit configuration
- enabling/disabling of the DS-30X network loop bus
- reporting of card status

**DS-30X loops** The interfaces provided by the line and trunk cards connect to conventional 2-wire (tip and ring) line facilities. IPE analog line and trunk cards convert the incoming analog voice and signaling information to digital form and route it to the Meridian 1 common equipment (CE) CPU over DS-30X network loops. Conversely, digital voice and signaling information from the CPU is sent over DS-30X network loops to the analog line and trunk cards where it is converted to analog form and applied to the line or trunk facility.

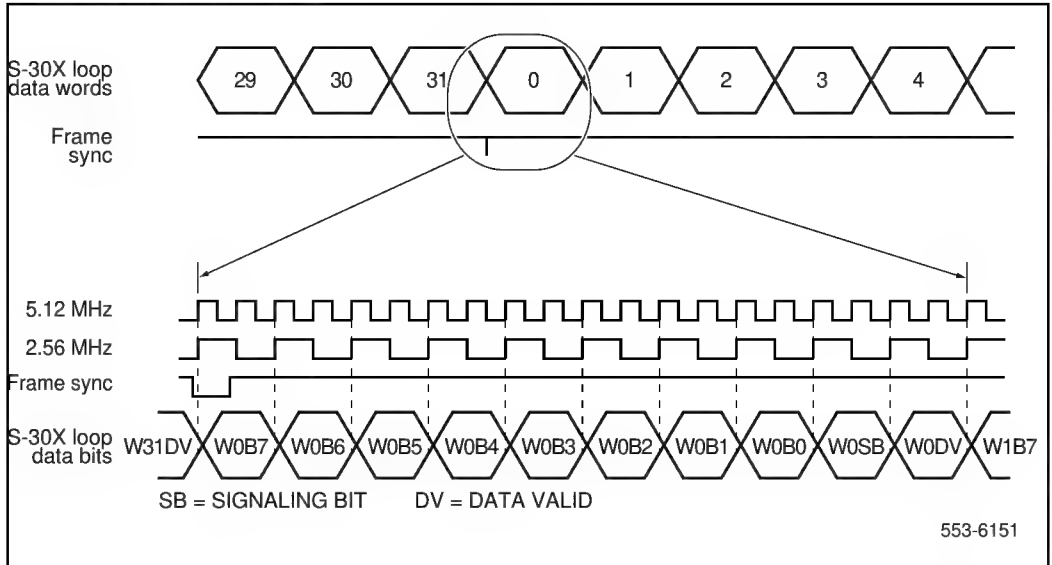
IPE digital line cards receive the data from the digital phone terminal as 512 kHz time compressed multiplexed (TCM) data. The digital line card converts that data to a format compatible with the DS-30X loop, and transmits it in the next available timeslot. When a word is received from the DS-30X loop, the digital line card converts it to the TCM format and transmits it to the digital phone terminal over the digital line facility.

A separate dedicated DS-30X network loop is extended between each IPE line/trunk card and the controller cards within an IPE module (or the controller circuits on a network/DTR card in a CE/PE module). A DS-30X network loop is composed of two synchronous serial data buses. One bus transports in the transmit (Tx) direction toward the line facility and the other in the receive (Rx) direction toward the Meridian 1 common equipment.

Each bus has 32 channels for pulse code modulated (PCM) voice data. Each channel consists of a 10-bit word (see [Figure 7](#)). Eight of the 10 bits are for PCM data, one bit is the call signaling bit, and the last bit is a data valid bit. The 8-bit PCM portion of a channel is called a *timeslot*. The DS-30X loop is clocked at 2.56 Mbps (one-half the 5.12 MHz clock frequency supplied by the controller card). Thus, the timeslot repetition rate for a single channel is 8 kHz. The controller card also supplies a locally generated 1 kHz frame sync signal for channel synchronization.

Signaling data is transmitted to and from the line cards using the call signaling bit within the 10-bit channel. When the line card detects a condition that the Meridian 1 switch needs to know about, it creates a 24-bit signaling word. This word is shifted out on the signaling bit for the associated channel one bit at a time during 24 successive DS-30X frames. Conversely, when the Meridian 1 switch sends signaling data to the line card, it is sent as a 24-bit word divided among 24 successive DS-30X frames.

**Figure 7**  
**DS-30X loop data format**



DS-30Y network loops extend between controller cards and superloop network cards in the common equipment, and function in a manner similar to DS-30X loops (see [Figure 5](#)). Essentially, a DS-30Y loop carries the PCM timeslot traffic of a DS-30X loop. Four DS-30Y network loops form a *superloop* with a capacity of 128 channels (120 usable timeslots). See *Meridian 1 system engineering* (553-3001-151) for more information on superloops.

**Card LAN link** Maintenance communications is the exchange of control and status data between IPE line or trunk cards and the CE CPU by way of the NT8D01 Controller Card. Maintenance data is transported via the *card LAN* link. This link is composed of two asynchronous serial buses (called the Async card LAN link in [Figure 6](#)). The output bus is used by the Meridian 1 controller for output of control data to the trunk card. The input bus is used by the Meridian 1 controller for input of trunk card status data.

A card LAN link bus is common to all of the line/trunk card slots within an IPE module (or IPE section of a CE/PE module). This bus is arranged in a master/slave configuration where the controller card is the master and all other cards are slaves. The module backplane provides each line/trunk card slot with a unique hardwired slot address. This slot address enables a slave card to respond when addressed by the controller card. The controller card communicates with only one slave at a time.

In normal operation, the controller card continually scans (polls) all of the slave cards connected to the card LAN to monitor their presence and operational status. The slave card sends replies to the controller on the input bus along with its card slot address for identification. In this reply, the slave informs the controller if any change in card status has taken place. The controller can then prompt the slave for specific information. Slaves only respond when prompted by the controller; they do not initiate exchange of control or status data on their own.

When an IPE line or trunk card is first plugged into the backplane, it runs a self-test. When the self test is completed, a properly functioning card responds to the next controller card poll with the self-test status. The controller then queries for card identification and other status information. The controller then downloads all applicable configuration data to the line/trunk card, initializes it, and puts it into an operational mode.

### **Peripheral equipment**

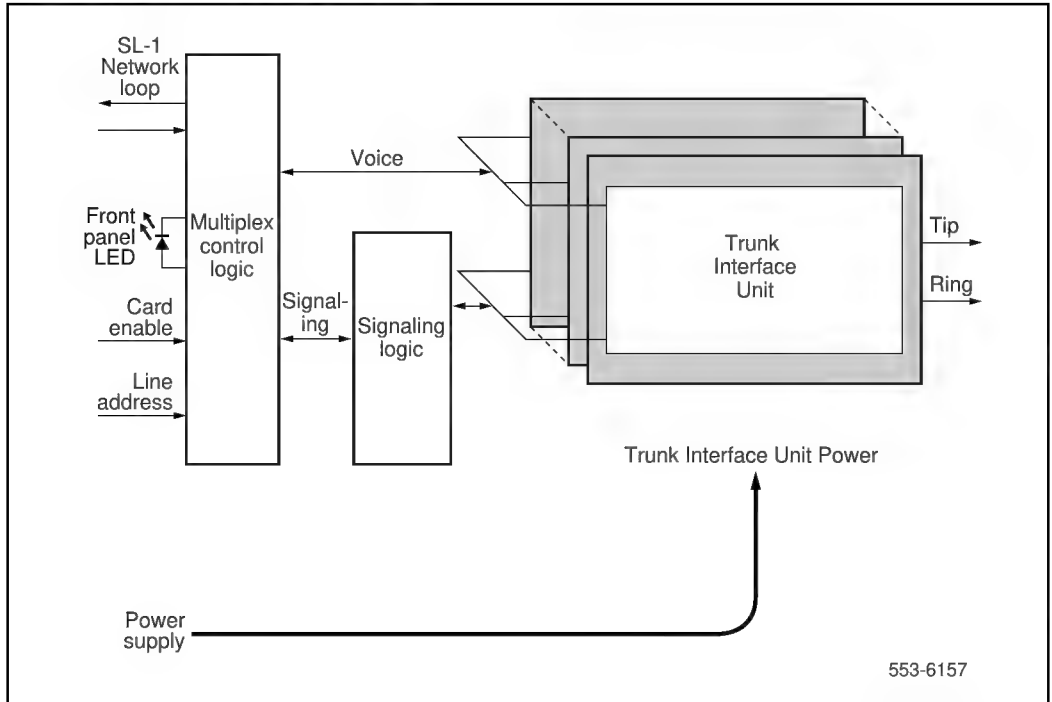
Peripheral equipment (PE) trunk cards all have a similar architecture.

[Figure 8](#) shows a typical PE trunk card architecture. The various trunk cards differ **only** in the number and types of trunk interface units.

Peripheral equipment (PE) trunk cards are not intelligent cards, but rather must work in conjunction with a QPC659 Dual-Loop Peripheral Buffer Card (see Figure 5 on page 17). The peripheral buffer card generates two sets of “card select” signals. A separate Card enable signal is generated for each card slot in the PE backplane. A 4-bit encoded Line address is used to select an individual trunk interface unit on that card.

The peripheral buffer card maintains a table of which trunk card and line unit address is assigned to a particular timeslot in the SL-1 network loop. It uses that information to generate the Card enable and Line address signals at the proper time.

**Figure 8**  
**Typical PE trunk card architecture**



A trunk unit is enabled by the simultaneous occurrence of a Card enable signal for the card that it resides on and a Line address that corresponds to the address of the line unit appearing on the Line address bus. When these conditions occur, the data that is present on the SL-1 Network loop at that time is written to and read from the line unit codec.

**SL-1 Network loops** The line interfaces provided by the line cards connect to conventional 2-wire (tip and ring) line facilities. Peripheral equipment (PE) analog line cards convert the incoming analog voice and signaling information to digital form and route it to the Meridian 1 common equipment (CE) CPU over SL-1 network loops. Conversely, digital voice and signaling information from the CPU is sent over SL-1 Network loops to the analog line cards where it is converted to analog form and applied to the line facility.

PE digital line cards receive the data from the digital phone terminal as 512 kHz time compressed multiplexed (TCM) data. The digital line card converts that data to a format compatible with the SL-1 Network loop, and transmits it in the next available timeslot. When a word is received from the SL-1 Network loop, the digital line card converts it to the TCM format and transmits it to the digital line facility.

Each loop has 32 timeslots for pulse code modulated (PCM) data. Each of the 32 channels is carried at 64 kbps (the standard rate for a digitized voice channel). The total data rate is therefore 2.048 Mbps.

Data on the loop is “bit-interleaved” instead of byte-interleaved as it is on the DS-30X loop. Instead of having a byte of data occupy eight successive timeslots on the loop, the SL-1 Network loop has the first 32 successive timeslots occupied (in order) by the sign bit from each channel. The next 32 successive timeslots are occupied by the most significant bit (MSB), and so on, until eight “subframes” of 32 timeslots each have been completed (see [Figure 9](#)).

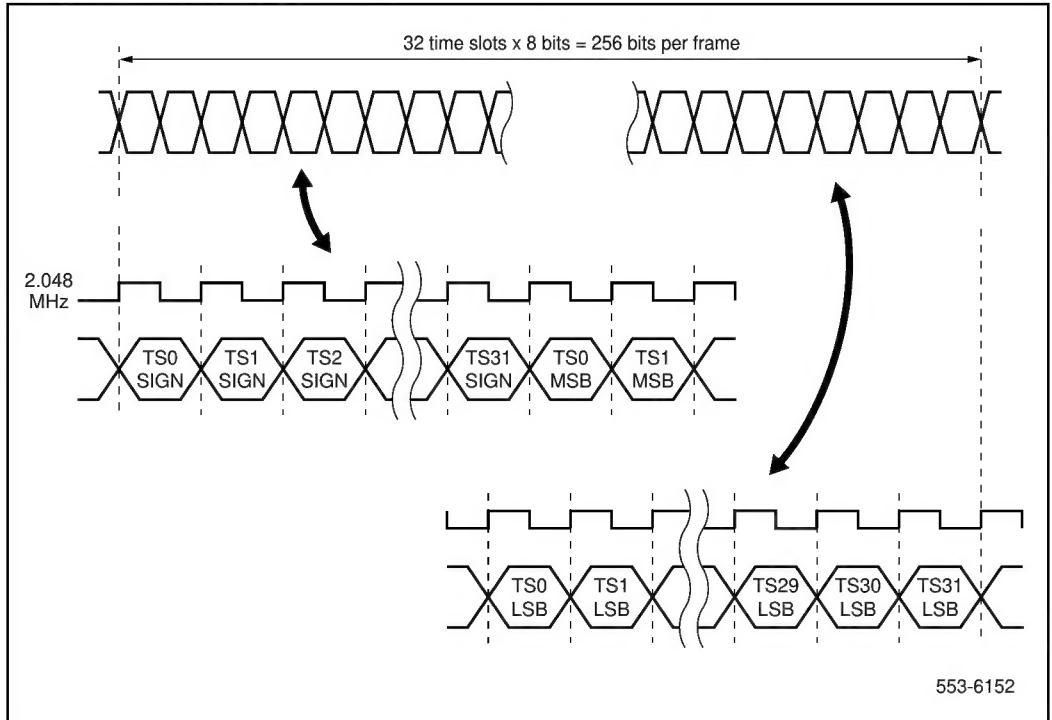
An SL-1 Network loop is composed of two synchronous serial data buses. One bus transports in the transmit (Tx) direction toward the line facility and the other in the receive (Rx) direction toward the Meridian 1 common equipment. When a terminal is enabled during a timeslot, its codec transmits one bit of PCM data toward the Meridian 1 CE and at the same time receives one bit of data from the Meridian 1 CE.

The timeslots are numbered 0 through 31. Timeslot 0 is reserved for signaling information. Timeslot 1 is not used. Timeslots 2 through 31 are used for voice data, giving a total of 30 usable timeslots for voice.

**SL-1 Network loop signaling** SL-1 Network loop signaling is used to send messages to and receive messages from the peripheral equipment cards. A typical message to the PE card directs the card to enable the front panel fault LED or enable signaling for a particular trunk. A typical message from the PE card tells the system processor that a trunk has gone off hook.

Messages are sent and received during timeslot 0. An enable signal TS0 (timeslot 0 enable) is generated during each timeslot 0. When the network card has a message for a particular peripheral card, it asserts the card enable signal for that card along with the TS0 signal. This continues on successive TS0s until a complete message has been sent. (See [Figure 9](#).)

**Figure 9**  
**SL-1 Network loop data format**

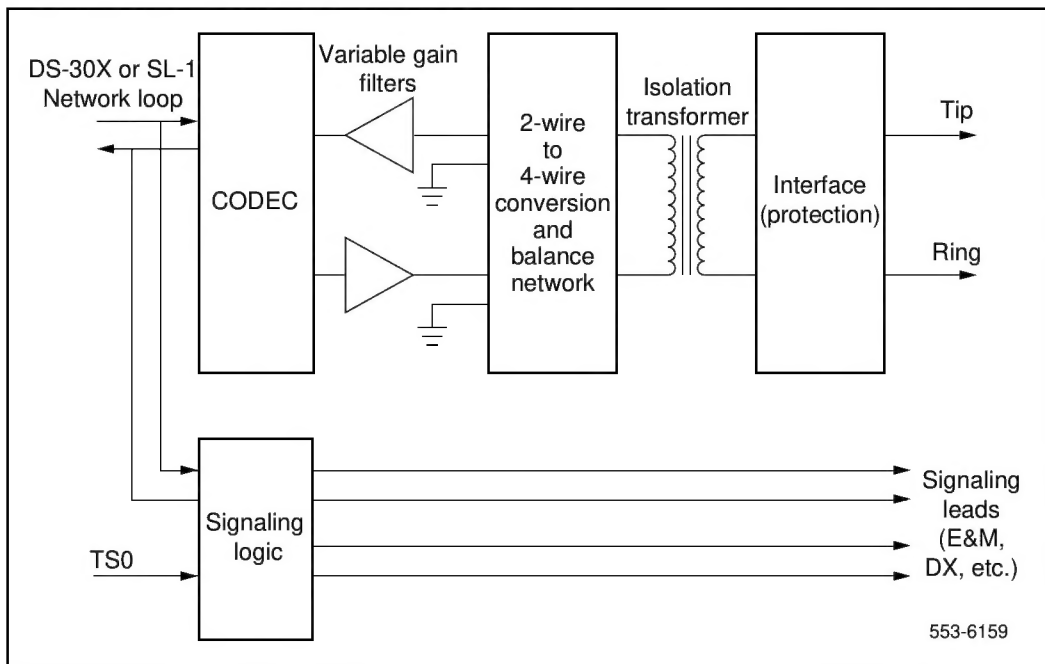


The network card regularly polls the PE cards during TS0 to see if any of them has a message to be sent. When a PE card has a message waiting it responds to the poll by sending a series of 1s during the next five successive timeslot 0s. The network card responds by sending a “message send enable” message (all 1s). The PE card replies by sending 1, 1, 1, 0, and then the message in successive timeslot 0s.

## Trunk interface unit

Once the 8-bit digital voice signal has been received by the trunk card, it must be converted back into an analog signal, filtered, and driven onto the analog trunk line through an impedance matching and balance network. The trunk interface also includes the logic necessary to place outgoing call signaling onto the trunk, or the logic to connect to special services such as recorded announcement and paging equipment. [Figure 10](#) shows a typical example of the logic that performs these functions. Each part of the trunk interface unit is discussed in the following section.

**Figure 10**  
**Typical trunk interface unit block diagram**





**Coder/Decoder circuit** The Coder/Decoder (codec) performs analog to digital (A/D) and digital to analog (D/A) conversion of the line analog voiceband signal to and from a digital PCM signal. This signal can be coded and decoded using either the A-Law or the  $\mu$ -Law companding algorithm. On some trunk cards the decoding algorithm depends of the type of codec installed when the board is built. On others, it is an option selected using a software overlay.

**Variable gain filters** Audio signals received from the analog phone trunk are passed through a low-pass analog to digital (A/D) monolithic filter that limits the frequency spread of the input signal to a nominal 200–3400 Hz bandwidth. The audio signal is then applied to the input of the codec. Audio signals coming from the codec are passed through a low-pass A/D monolithic filter that integrates the amplitude modulated pulses coming from the codec, and then filters and amplifies the result. On some of the trunk cards, the gain of these filters can be programmed by the system controller. This allows the system to make up for line losses according to the loss plan.

**Balancing network** Depending on the card type, the balancing network is capable of providing either a 600  $\Omega$  or a 900  $\Omega$  (or both) impedance matching network. It also converts the 2-wire transmission path (tip and ring) to a 4-wire transmission path (Rx/ground and Tx/ground). The balancing network is a transformer/analog (hybrid) circuit combination.

**Signaling circuits** Signaling circuits are relays that place outgoing call signaling onto the trunk. Signal detection circuits monitor the incoming call signaling.

**Control signals** Control signals and logic are provided when the trunk is going to be connected to special services such as recorded announcement and paging equipment.